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Workflow Methodology Development of RPA Solution for A Vietnamese Bank: A Case Study of Korkia Oy

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Abstract

Workflow methodology development of RPA solution for a Vietnamese bank: a case study of Korkia Oy

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Robotic Process Automation (RPA) is an emergent technology since 2015 and is considered to be the next significant phenomenon in business processes around the world, especially in Central and Eastern Europe. The Finnish Financial Group WallStreet and Finnish Consulting Group Eera have joined forces to become Korkia Group. Korkia has a background in consulting, investing and cooperate finance, focusing on RPA from 2016. To date, Korkia has accomplished many successful projects across Finland, Chile and UK. In 2018, Korkia's next destination is the Asian market in general and particularly the Vietnamese market. As RPA is considered extraordinary in Asia, Korkia has encountered miscellaneous challenges in Vietnam, specifically in negotiating with a Vietnamese bank, one of their first clients in the banking industry. Thus, RPA in Asia requires further analysis in order to gain a superior understanding and administration of it.

This research proposes to give an overview of RPA in the financial industry and an analysis of RPA vendors in the current market. In terms of RPA vendors, the research indicates how each vendor governs the market and emphasizes which vendor might correspond to Korkia's need. Furthermore, this research exploits the software development life cycle (SDLC) Waterfall method to implement the RPA development for the Vietnamese bank, Korkia's client. Following all five stages from the SDLC Waterfall method, the thesis delivers a process description, a process analysis, a list of requirements, a process roadmap design and significantly process development based on REFramework. All the investigations discussed in the research, especially the process framework architecture design can be universally applied to more clients of Korkia in the near future.

Keywords: Robotic Process Automation, Software Robot, Financial Industry, Banking

Table of Contents

1 Introduction

1.1 Company

Korkia is an international Group whose expertises are in investing, private equity, venture insight, consulting and corporate finance. Korkia was established when the Finnish financial group WallStreet joins forces with the consulting group Eera in 2017. Its team has over 70 experienced business professionals with 9 office locations in Finland, UK, UAE and Vietnam. In 2017, Korkia sales were 6.5 million euro with the growth of 100% compared to year 2016. The success story is contributed by one of their business approaches leading in knowledge work automation. Korkia provides Robotic Process Automation (RPA) services of strategic planning, process development as well as piloting and deployment in Northern EU, Latin America and South-East Asia. Korkia has experienced with references in different sectors such as Banking, Insurance, Securities, Electricity, Telecommunication, IT, Tax agency, etc. (Duong 2018)

1.2 Technology

Robotic Process Automation (RPA) is defined as a software robot that can manipulate any execution of repetitive processes with existing interfaces and structures of software applications in the same conduct a human does. RPA solution is different than an IT tradition in a way that it is not only full-stack developed with programming languages by IT developers but also trained by business users in the logic of process flow, human behaviors and ways of delivering problem-solving methods (The Institute for Robotic Process Automation 2015, 22). RPA is described as an easy, fast and cost-saving solution to increase the efficiency of the organization, optimize the business process, reduce the turnaround and minimize possible human errors (The Institute for Robotic Process Automation 2015, 28-29).

1.3 Project background

In 2018, Korkia's strategy is to amplify the scope of enterprise in Asia, starting with Vietnam. As Vietnam is a developing country, the technology is yet embryonic compared to Finland. Majority of work in any company are done on paper or by hand-writing, thousands of adolescents are working in data entry areas, this lavishes the youthful workforce and thus make the economy sluggish. And the banking industry in Vietnam does not elude from that actuality.

Consequently, laborious bureaucratic hassle prevents Vietnamese banks from gain great importance on the economy. From hundreds of banks in Vietnam, one of them perceives the substantiality and schemes for automating their whole system in 2020. This private bank situated in Hanoi, the capital of Vietnam, which has more than 9000 officers, 140 branches and 850 transaction offices. As it is a gigantic company, it has a generous number of paperwork daily, abundant of processes to handle, total of them are performed manually on paper.

Whereby the program associating Vietnamese and Finnish enterprises, the private bank and Korkia converge and collaborate. Apperceiving the aim of this private bank, Korkia consults them on implementing Robotic Process Automation (RPA) into their system. As RPA is obscure in Vietnam, both enterprises agree on making a pilot for one chosen from thousands of processes – which is the process of permission for granting credit to online customers. Based on that case from the private bank, this research will dissert leitmotif in terms of RPA and workflow development pertinent to Vietnam.

1.4 Aims and Objectives

As mentioned above, the objective of Korkia is to deliver the pilot for one chosen process preferred by the private bank. This objective assists Korkia in achieving their long-term goal as building up RPA management platform orchestrating thousands of robots in various banks around Vietnam. To help Korkia accomplishing that, the authors propose a workflow model of RPA solution based on the process of permission for granting credit to online customers. This serves as a standard guideline for the upcoming clients that Korkia collaborate henceforward.

With the aim of developing the workflow model for the chosen process, this research sets out 5 objectives that undertaking 5 phases of the workflow. Firstly, the research provides a literature review as theoretical proof that RPA solution is appropriate for the financial industry. Secondly, the research brings out an RPA vendors' overview and specifies which sector each RPA vendor regulates as a groundwork for choosing the most pertinent development platform afterward. Thirdly, the authors introduce a method of development – SDLC Waterfall - with detailed descriptions and advancement orders. Fourthly, the implementation plan is defined by applying the SDLC Waterfall into the chosen process to emphasize the outcomes of each step in the method of development. Finally, the research presents the framework architecture design as the framework model that can be employed in diverse processes within the private bank.

2 Robotic Process Automation (RPA) in financial industry

This section provides a holistic view of RPA in financial industry, especially the implementation of RPA in different processes. The authors' method is to conduct a literature review in different books and online materials. Therefore, the authors can answer a critical question precisely and unbiasedly that why RPA should be implemented instead of other IT solution for system automation. As a result, the project can be built based on a solid foundation and confidence that RPA is the best-applied solution for automating any manual and repeated tasks with fast deployment and cost optimization.

2.1 Why Banks must invest in RPA

The culture of “do more with less” in banks requires people to be innovative and productive in doing work instead of only being a hard-working staff. It is especially accurate with financial service where there is a high density of competition. Therefore, banks must be always under a nonstop process of development to satisfy customers. Moreover, the majority of the workload in banking industry is currently assigned to manual tasks. The increasing workload leads to the increment of staffs, facility investment and many more which lets banks are under pressure to optimize costs. RPA appears as a solution for all mentioned matters. (Hosadurga 2017)

2.2 What RPA can do in Banks

In general, RPA has ability advantages in any financial processes that contain structured digital input, are repetitive and have a low amount of exception such as reporting, data preparation, application processing, knowledge management, transferring data and saving data. (Duong 2018)

In details, there is a list of specific job tasks that can be automated by RPA. Firstly, a robot can be built as an automated system of master data management. RPA allows automation in different processes of collecting, integrating, matching, centralizing and distributing data around the organization. Secondly, a robot can automate core processes or can be trained to work with multiple systems and applications to deliver a specific workflow as a human does. Thirdly, a robot can be used in checking data and tracking errors from both internal and external sources. Fourthly, a robot can deliver financial reports, reconciliation, process management and quality control. Last but not least, a robot can support customer service by delivering any repeated tasks as needed without any involvement of human (EYGM 2017).

2.3 Benefits that Banks can gain from RPA

According to Robotic Process Automation (2018), there are both direct and indirect benefits of RPA that can enhance the efficiency and cost optimization. There are three direct benefits and two indirect benefits.

Direct benefits

Firstly, it is a Full-time employee (FTE) savings. RPA allows saving a considerable cost in human resources which is approximately one-third of the cost per labor. Moreover, a significant enhancement of productivity compared to FTE is caused by not only a robot’s non-stop working in every hour of 365 days but also an ability of continuously learning and improving in their performance.

Secondly, it improves data analytics. RPA has the ability to manage data centrally and keep track of any processing transactions in real time. In addition, any analysis is done based on defined rules and structure that Robot has been trained by business users. Therefore, a robot can return accurate analytics value as soon as it receives any newly updated data. Thanks to that, a data analytics outcome has been increased in quality, quantity and speed.

Last but not least, RPA provides a flexibility in scaling. RPA solution gives an opportunity in fast resizing a project capacity without any much financial investment in development. When more workloads come due to the increase of customers' need, RPA allows business units in banks to continue training current robots with new tasks (if needed) or just immediately activate more robots without any extra development efforts to keep process always be efficient with sufficient robotic labors. Moreover, a process of increase and decrease in robot's numbers can be automated based on defined rules of scalability which makes RPA solution to be stable and sustainable in operational growth.

Indirect benefits

There are thousands of repetitive and tedious processes in banks that can be done by robots. Therefore, RPA solution brings happiness to staffs and motivates them to work in more challenging but interesting missions that require higher level of knowledge. In addition, a guarantee of quality, speed and minimum of errors in delivering a service brings satisfaction to customers.

2.4 Some of the use cases in banking industry

Online loan application

There are an abundant amount of manual tasks in the process between a first step of receiving online loan application and a final step of providing loan offer proposal. RPA solution allows customer's application to be analyzed automatically. A robot collects data in required fields of an online application and checks whether the provided information is qualified or not. A decision is made based on the analysis. The robot will then send to qualified customer a loan offer proposal.

The loan process is one of the crucial activities that generate profits to the bank. Boosting the productivity but shortening the amount of time makes business have more competitive advantages with other banks. In addition, an automation liberates employees from repeated assignments and upgrade their tasks into a higher level of knowledge work such as strategic planning, service designing and many more vibrant tasks. This direction of change can also raise worker motivation and learning efforts. (Duong 2018)

Foreigner exchange and selling stocks check

Banks often benchmark each other websites as references for their service. For instance, banks provide a foreign exchange or selling stock services at a specific rate. The reconciliation lets banks offer to their customers the most appropriate fee. However, the task requires many manual working hours and mistakes might happen anytime. RPA solution allows this reconciliation to be automated. A robot will fetch data from competitor sites and check whether any differences in comparison with values in their own site. A difference will be noted down in a report. Then robot sets data updates on the company site and other relevant system required. Any exceptions that cannot be handled by automation will be sent as notifications to employee's emails for manual process.

The adoption of RPA enhances information quality and avoid human mistakes with less effort and cost of IT development. In addition, an automation once again releases employees from repeated tasks and upgrade their tasks into a higher level of knowledge work. (Duong 2018)

Data migration from bank to bank

A unique situation happens when a particular bank acquires their competitors and requires a process of migrating data into one system. RPA solution is developed to automate the process. A robot is trained to fetch all customer data from acquired banking systems to the same structured data table. Then, a robot distributes each field of data table to their own core banking system.

In this case, without RPA, employees are usually required to do most of the job manually. Any supports by IT tradition solution takes months to deliver and requires a huge financial investment. However, with RPA, a robot delivers its process without the involvement of human resources. RPA with the characteristic of fast deployment also allows the company to invest fewer fees in development. Therefore, RPA handles two problems at the same time. Firstly, it solves the issue of lacking human resources by transferring human work into robot work. Secondly, RPA is a solution of cost optimization. (Duong 2018)

In conclusion, the research of robotic process automation in financial industry demonstrates that RPA is a proven concept which has been integrated successfully into different banking processes. RPA brings huge benefits of quality and efficiency improvement, cost reduction, fast development and deployment. Therefore, although RPA is a new technology concept, a thesis is confirmed to be developed with conviction.

3 RPA vendors

This section is mainly developed based on literature review and internet search. Some of the analysis is provided based on practical experiences of the authors. An outcome of the research is to develop a foundation that can be used for choosing the most applicable vendor for a project afterward.

3.1 Overview of RPA vendors

RPA vendors provide their platform with tools for business users to develop different types of robots based on their specific needs (Everest Group Research 2016). There are currently over 50 RPA product vendors in the market which is predicted to produce up to 4 million robots replacing human work in 2021 (Clair, Cullen and King 2017). However, not every vendor has its own development tool that suits a specific automation's need. Indeed, any processes that require being automated ought to be studied and analyzed before a vendor is chosen. The analysis guarantees that a requested need of automation matches with the capabilities of a preferred RPA tool. Thus, an RPA development process can be planned cautiously to be productive, efficient and cost-optimized (Parvez & Agaram 2017, 20).

Figure 1: Robotic Process Automation Vendors ranking in Q1, 2017 (Clair et al. 2017, 8)

According to Clair et al. (2017), there are top 12 product vendors in the market which are presented in figure 1. They are all RPA vendors whose total revenue is a minimum of $3 million in Q1, 2017 and have strong customers references over a year in at least 2 large regions of any parts of Asia, Europe, North America and Africa. Among top 12s, there are 3 significant RPA vendors which are Automation Anywhere, BluePrism and UiPath. Those market leaders prove their visions with a long-term strategy, great market presence and great capacities in RPA development that can handle a diversity of automation cases in different levels of complication. Therefore, the authors select those 3 vendors for further detailed analysis in the thesis. Nevertheless, although WorkFusion is not as strong as the three RPA leaders, its position among strong performers shows the vendor's undeniable efforts and great potentiality to become the next giant in a near future. The affirmation is even more reliable when it is

acknowledged that WorkFusion has just provided their RPA platform since 2015 which turns them to be one of the youngest vendors with a significant growth in the market (WorkFusion 2018). Thanks to that recognition, the authors also count WorkFusion as the fourth vendor.

3.2 RPA Vendor Profiles

This section provides a detailed description of four chosen RPA vendors.

3.2.1 Automation Anywhere

Automation Anywhere is a private firm with over 500 clients who have used their RPA services. The company's main office is in the US. There are 9 more offices in other continents. Automation Anywhere's main system is a front-end automation system that specializes in recording rule-based processes via PC's screen. In addition, the vendor has strong cognitive tools such as IQ Bots and Language Bots to support decision-making in partly unstructured processes. It allows robots to be adaptive with new process's steps or self-adjust any changes in application interfaces. Therefore, Automation Anywhere has a huge advantage compared to other RPA vendors in executing a process automation from start to end without human interference. Its RPA development tool supplies different functional components in their automation library that business users can build up a robot without coding. Their license's cost is the most expensive compared to other RPA Vendors. The company has launched its RPA platform since 2005, which is one of the oldest RPA platforms in the market. Thus, the company has significant numbers of partners in different aspects of cooperation. (Tornbohm & Dunie 2017, 10-11).

3.2.2 Blue Prism

Blue Prism reaches its revenue of over $16 million in 2016. The company was founded in 2001 and introduced its first RPA software in 2008. Their offices are currently located in UK and US. Blue Prism software robots are developed to operate their work independently and orchestrated through cloud platforms. Hence, a robot has an ability to interact and connect with software apps, data centers and any other required sources which are built by JAVA, CITRIX and HTML without an integration through APIs. Blue Prism tool provides a configuration language which allows business users designing a specific automated process by clicking and dragging or using configured objects. Building up a strong partner's network is their long-term development strategy. One segment of that is to corporate with smart machine firms which specializes in different high-tech industrial aspects such as optical character recognition (OCR). Hence, Blue Prism solution can be a more competitive advantage than other RPA vendors. Blue Prism provides their license of minimum 10 robots for 3 years. In 2016, there are over 120 customers using their RPA platform in USA, Europe and Asia. Most of them are well-known institutions from different sectors of banking, insurance, healthcare, telecom and government (Tornbohm & Dunie 2017, 12-13).

3.2.3 UiPath

UiPath has launched its RPA platform since 2013. The company's headquarter is in the UK. Their RPA platform consists of three products which are Studio, Orchestrator and Robot. UiPath Studio is a software that provides configured tools and automation library to develop a robot without coding. Developers can apply VB.NET or C#.NET as a programming language to develop new functions and generate reusable contents for library for their own benefits. UiPath Orchestrator is a web app server where robots can be orchestrated. There are attended and unattended robots as final products that can perform an automation in front-office and back-office processes. A front-office automation is an automation that lets business users interacting with robots within a process. Meanwhile, a back-office automation allows robots to perform their tasks independently without human interference. Both robots have capacities in automating desktop apps, SAP, Citrix, webs and other mainframes (UiPath 2008). UiPath's licensing model is acquiring per robot and does not require users to commit to a specific number of robots. Their license's price is cheaper than Automation Anywhere and Blue Prism. The vendor has around 150 customers in 2016. Some of them are enterprises in top 500 global companies. Most of their revenue comes from their partner network (Tornbohm & Dunie 2017, 31-31).

3.2.4 WorkFusion

WorkFusion is a private company whose headquarter is in the US. Its RPA platform was launched in 2015 called Smart Process Automation (SPA). SPA is part of their toolkit named WorkFusion Intelligent Automation which comprises other products made by artificial intelligence and cognitive automation. Therefore, WorkFusion can perform a robotic process automation with unstructured data by the algorithms support from machine learning. SPA provides RPA Express as a free-of-charge workspace for users to develop their bots with a set of defaulted tool and templates. The SPA control tower is like UiPath Orchestrator which can corporate and assign RPA bots in different requested tasks. The robot has capacities in automating different applications such as Citrix, SAP, Oracle and Office. SPA allows being managed both on cloud and in the physical premise. Their licensing model requires no commitment to a specific number of robots. WorkFusion's profit is from direct sales or through their deployment partners. Their service strategy is to offer customers an RPA solution without cost. However, customers will be charged when they upgrade their products with cognitive functions such as WorkFusion ChatBots. IN 2016, the vendor has 35 large institutions as their customers in different sectors such as banking & financial services, insurance, commerce, etc (Tornbohm & Dunie 2017, 32-33).

3.3 RPA Vendor Analysis

Clair et al. (2017) published a list of top 12 RPA vendors that have been applied by their scoring system based on the scale from 0(weak) to 5(strong) in different aspects of their current offering, strategy and market presence. The Table 1 summarizes scores of four vendors: Automation Anywhere, BluePrism, UiPath and WorkFusion. Then, the authors will accomplish the analysis that can support in choosing the right RPA tool for the robot's development.

	Forrester's weighting	Automation Anywhere	Blue Prism	UIPath	Workfusion
Current offering	50 %	3,69	3,39	3,53	3,09
Bot development and core functions	20 %	3,07	2,5	3,25	2,3
Control room, system management, reporting, and resilience	10 %	2,8	3,8	3,8	3,45
RPA Analytics	10 %	3,66	2,0	3,66	3,0
Architecture	10 %	4,33	3,66	3,99	2,99
Breadth of use case	10 %	4,1	3,4	2,75	2,15
Deployment, governance and security	40 %	3,66	4,0	3,66	3,68
Strategy	50 %	4,25	4,25	4,0	3,25
Vision, execution, and strategy	100 %	4,25	4,25	4,0	3,25
Market Presence	0 %	4,5	4,0	2,0	2,0
Installed base	100 %	4,5	4,0	2,0	2,0

Table 1. Chosen RPA Vendors scored by Clair et al.'s evaluating system (2017, 9)

In the table 1, Forrester (2017) studies three criteria. They are current offering, which is examined by "the vendor's robot development and core functions, control room, system management, reporting and resilience, RPA analytics, architecture, breadth of use case, development, governance and security", strategy, which is analysed by "the vendor's vision, execution, and strategy" and market presence, which is inspected by "the installed base of customers". Based on those scores, the authors generate two consecutive radar charts in figure 2 which visualizes both generic and detailed comparison between each vendor's scores.

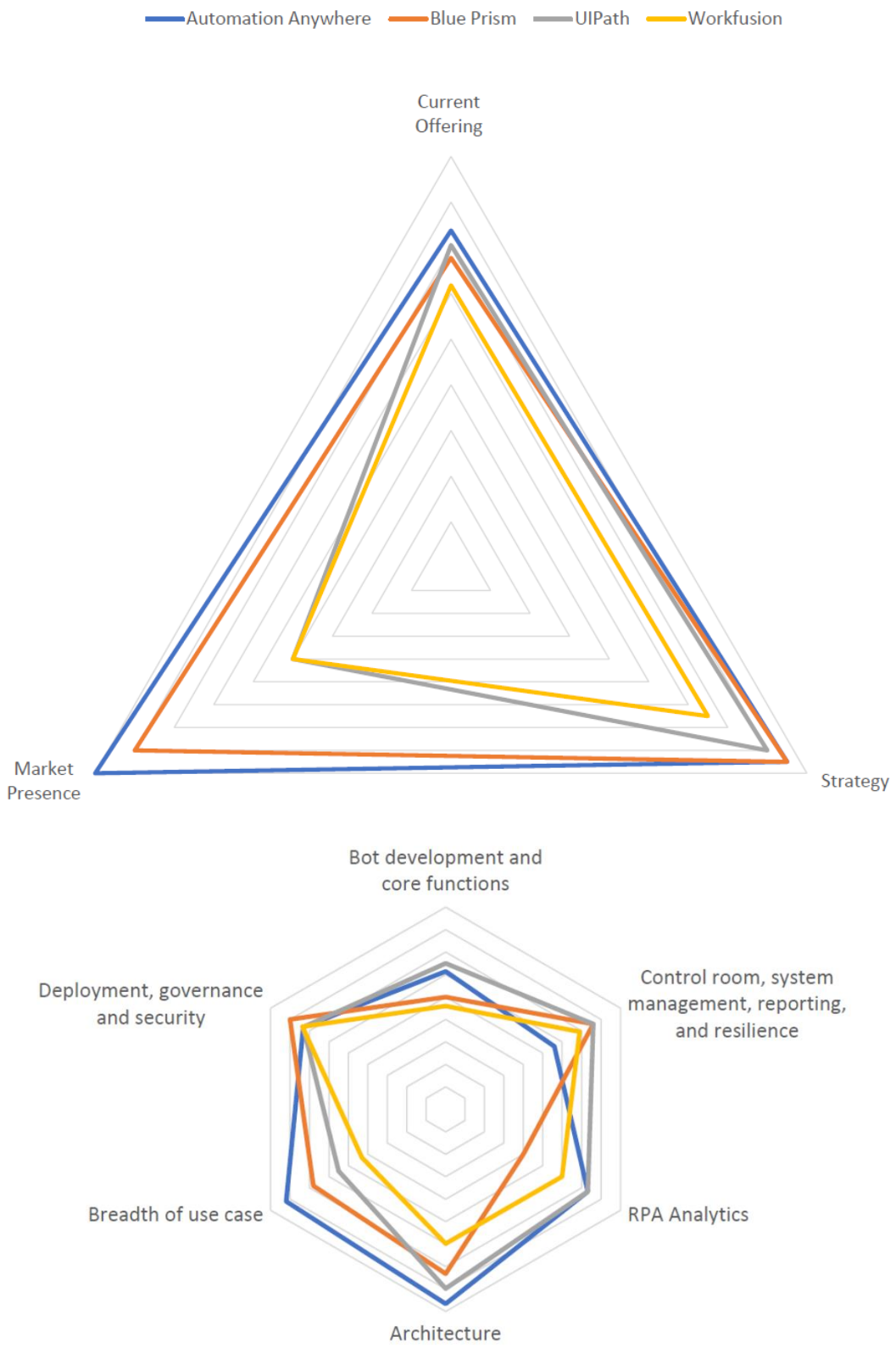


Figure 2.A generic and detailed comparison between Automation Anywhere, Blue Prism, Ui-Path and WorkFusion

The first chart demonstrates that Automation Anywhere (AA) is superior to others, especially in market presence. It is understandable since its platform is one of the biggest RPA platforms with a significant number of partners and customers in the market. However, UiPath and Blue Prism are currently AA's challengers. Blue Prism has the same score with AA in the angle of Strategy, which indicates that the vendor has a long-term vision and plan of action in developing a sustainable RPA business. Meanwhile, UiPath proves its excellence through their current offering by earning a second position in this angle. It consolidates customer's confidence in the vendor's technology.

The second chart analyzed in details elements inside the edge of the current offering. AA continues to show its advantage in the range of breadth of use case and architecture. Blue Prism displays its supremacy in deployment, governance and security. UiPath emphasizes once again its dominance in robot's development and core functions. AA and UiPath share their same quality in RPA analytics. UiPath and Blue Prism are experienced with the same value in control room, system management, reporting and resilience.

In overall, AA is the most substantial vendor, remarkably in the breadth of use case, architecture and RPA analytics. Blue Prism is notable for deployment, governance and security and control room, system management, reporting and resilience. UiPath is outstanding in both development and core function, control room, system management, reporting and resilience and RPA analytics. WorkFusion needs more efforts to be competitive in comparison to the top three market leaders. Nevertheless, although the vendor does not have a high breadth of use case, it has high score equally in all other elements. It highlights the stability of their RPA platform.

4 Method of development: SDLC Waterfall model

Since RPA is confirmed to be the most suitable option for project development, the authors execute further by choosing SDLC waterfall model as a development method. the objectives are to provide a description of the model and clarify reasons for the selection of that approach.

Therefore, this section firstly provides theoretical knowledge of SDLC. The waterfall model is then described under the scope of SDLC. Lastly, the authors analyze the appropriateness in applying an SDLC Waterfall model in the Vietnamese bank's project.

4.1 Software Development Life Cycle (SDLC)

According to SDLC Overview (Tutorials Point 2018a), SDLC stands for Software Development Life Cycle. SDLC is a framework that provides steps to design, develop and test a software

product. SDLC aims to increase the quality of both software and development process. There are six steps which formed a life cycle in that software development method.

Planning and requirement analysis:

This is the most essential and fundamental stage in SDLC. A step is delivered by getting inputs from people who have both direct and indirect effects in the whole process. Those inputs are utilized to plan project descriptions, product feasibility development and possible process risk identification.

Defining requirements:

After delivering a requirement analysis, it is documented and get approved by customers. A document is done by following an SRS template which is Software Requirement Specification template. An SRS includes all requirements of a quality software product from designing to developing a life cycle.

Designing a product architecture:

Based on SRS, a product designer will then develop a DDS which is design document specification. An DDS provides all definition of product's architect models and data flows of any external and third-party modules.

Developing a product:

The product is built in this phase. Therefore, a programing language or any developing tool should be chosen based on a DDS which has been written in a previous step.

Testing a product:

An activity of product testing has been done in each stage of SDLC model. However, a final testing will be done in a more comprehensive way that requires all testing indicators be qualified before deployment.

Deployment in a market and maintenance:

There are two steps for production deployment. Firstly, a product is deployed in a limited market to test its functions and level of impacts in the business environment. Secondly, based on that testing, a product is suggested to expand its scope in more market segments. Maintenance and supporting service are always ready to be delivered based on the customer's need.

4.2 Waterfall

In SDLC Overview (Tutorials Point 2018a), waterfall model is under the scope of SDLC and used for software development. The waterfall model is simple, easy to understand and manage due to the rigidity of the model. Essentially, waterfall methodology is a framework for software development which has series of phases, starting with analyzing requirement and up to product release and maintenance. Its progress proceeds from one stage to another, each phase has specific deliverables and a review process. Waterfall methodology includes six steps:

Requirement gathering and analysis: This stage requires firstly an activity of defining all requirements for an entire development process. Secondly, the identification of those concerns is analyzed and documented as a requirement understanding document.

System design: The specific document in the previous stage is studied to make a system design in both high and low level. A system design supports in defining and specifying product requirement and architect.

Implementation: An output of system design is an input of implementation. The code is generated to build up a product in different small units. Each unit is then put under unit testing for errors tracking before entering next stage.

System Integration and Testing: All developed units are integrated into a system. The entire product will go through a system testing. Faults and failures are adjusted to make sure a system works as expected. All testing activities are then documented in a system testing report.

Deployment: After a product has successfully passed all testing processes, it is deployed and released into the business environment.

Maintenance: This stage is where a product receives different feedbacks from users. A maintenance service lets developers fix any reported issues and later improve a product with better versions.

A waterfall model has been chosen because of its simplicity and suitability for small scope of developing one robot in one process. One phase at a time also permits an action of maintaining quality control handily. Moreover, customers ask for understanding every step of a process. Thus, applying this model lets Korkia put the Vietnamese bank in the loop of observation and updated due to detailed documents after each step. However, it might be concerned that an SDLC waterfall is slow in dealing with possible changes that may happen in any stages of a project. Additionally, a model might not be applicable to the company's proposal of a continuous cooperation with a larger scope such as producing multiple robots for different processes. Nevertheless, the current circumstance persuades the authors that Korkia's team

should apply SDLC waterfall model because most importantly, it matches well with customer requirement of a straightforward and testable product.

5 Implementation plan

An implementation plan specifies how the project is delivered and managed. It provides a comprehensive plan for a research and development process that supports all project requirements to be successfully accomplished in project execution phase. An RPA solution needs an implementation plan to have a holistic view of all required steps.

Since SDLC Waterfall is a development framework, there are six fundamental steps which have been discussed in the section of methodology. However, an RPA software robot requires two additional steps before the stage of requirement gathering and analysis which are process description and process analysis. It is understandable because RPA robot delivers a process automation. Comprehending the process description and its analysis is a substantial foundation to build up a quality solution. Therefore, there are eight crucial stages for an RPA development.

First and foremost, the authors deliver a process description by conducting interviews with business units' managers. It is important for an RPA consultant to acknowledge the flow of a business process. It gives an opportunity to inspect whether a process can be automated or not, which level of automation a process can be developed and which requirements in concern of both business and technical sides are in need for an RPA implementation. Now, the process of providing customer's permission in using credit card after their online registration is delivered in many steps done by the Vietnamese bank's employees. A process description provides from general to specific information of the Vietnamese bank's process. An outcome of process description is a document which supplies a process diagram with followed explanations in each step.

Secondly, the authors deliver a process analysis based on the process description documentation. The method is to organize workshops to meet up and discuss with employees in different business units involved in a process. The activity generates an opportunity for Korkia to have a practical point of views. Then, the task is to identify which sub-process needs RPA for productivity improvement and prioritize it for pilot execution. The authors also demonstrate the suitability of that sub-process for an RPA development.

Thirdly, the authors deliver a requirement gathering and analysis. Based on group discussion and the Software Requirement Specifications (SRS) document guideline, the task is to provide a list of requirements to deliver a successful RPA development. It comprises necessary resources that Korkia requests to be supported by the Vietnamese bank and a list of principles that Korkia ought to achieve to complete a project.

Fourthly, the authors deliver a process roadmap design by writing a roadmap design document. The method is brainstorming and group discussion with the supervision of Korkia senior consultants. This document describes the designed flow of a process roadmap which explains how the robot is connected to the broader business environment and how the robot performs a process. The purpose of this document is to describe a solution on both high and low level that allows not only developers to understand but also business personnel who is not familiar with RPA to acknowledge what Robot can deliver. An outcome of the architecture design is a roadmap with detailed process steps, an exception handling, error mapping and handling documents.

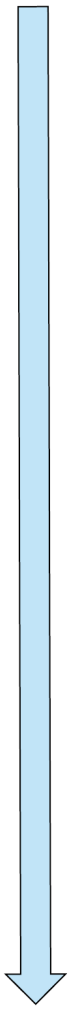
Fifthly, the authors deliver a development. In this stage, the authors choose the most appropriate RPA tool. The progress is developed based on the structure of Robotic Enterprise Framework (REFramework). In this development, the authors explain the purpose of using REFramework and discuss its component functions. An outcome of development is a description document that illustrates how a pilot is implemented by using REFramework. Therefore, the authors would like to convince Korkia to apply this framework not only in a pilot but also as a standardized model in other RPA projects.

Sixthly, the authors deliver a deployment which matches five main principles of a successfully developed robot. Firstly, a robot has a logical updating data process which minimizes possible exceptions that require the involvement of human resources. Secondly, a robot is user-friendly that people with limited knowledge of technology can corporate with. Thirdly, a robot can be scalable which means that it can be applied in different bank offices. Fourthly, a robot can enhance the operation speed, productivity and cost saving. Finally, a robot runs excellently with minimum of errors (Duong 2018)

Seventhly, the authors deliver a live testing. Testing indicators are designed for validation and testing purpose which is about to assess the compatibility of a robot with the Vietnamese bank's environment. A successful production must have full functionalities and ability to pass all exceptions in the business environment.

Last but not least, the authors deliver a maintenance service. the plan is to apply the maintenance strategy based on Lean thinking for maintenance process (Mostafa et al. 2015). There are two sub-stages which are Design-Out Maintenance (DOM) and Preventive Maintenance (PM) in the stage of before detecting failures and Corrective Maintenance (CM) in the stage of After detecting the failure. DOM is a process of improving a better product version and PM is then applied to eliminate the probability of any new product faults or system errors. CM is a process that a developer must fix a failure immediately when it happens. Based on that strategy, the plan of maintenance activities is performed before and after failure detected.

There are eight steps in the whole project. However, within the scope of the thesis, the authors focus on the first five steps which are process description, process analysis, requirement gathering and analysis, architecture design and process development. Table 2 shows a summary of those five steps.



STEPS	DESCRIPTION
PROCESS DESCRIPTION	Method: Conduct interviews with business units' managers Objective: Deliver a process description document with business diagram
PROCESS ANALYSIS	Method: Organize workshop to meet up with employees in different business units Objectives: - Identify which subprocess needs RPA for productivity improvement - Provide a process diagram of chosen subprocess with short description - Demonstrate that subprocess is suitable for RPA development
REQUIREMENT GATHERING AND ANALYSIS	Method: Group discussion and guideline of SRS document Objectives: A list of requirement with proper clarification
PROCESS ROADMAP DESIGN	Method: Brainstorming and group discussion with the supervision of Korkia senior consultants Objectives: -Design a roadmap with detailed process steps -Provide exception handling, error mapping and handling and In-scope application details
PROCESS DEVELOPMENT	Method: Robotic enterprise framework (REFramework) Objectives: -A description document that illustrates how a pilot is implemented by using REFramework -A recommendation for Korkia to apply REFramework as RPA development model

Table 2. Applied methods and thesis objectives in five project steps

6 Process framework architecture design

6.1 Process description

By having interviews with business unit’s manager to discuss the comprehensive process life cycle, it enables the authors to present the acknowledgment of process description under a business diagram with detailed interpretation. A project description is divided into three parts: synthetic parameter, process diagram and process detailed interpretations.

6.1.1 Synthetic parameter

A synthetic parameter provides input and output of a process. It orientates the business diagram to follow one standardization.

Parameter	Description	Requirement
Input	Customers enumerate information for request of credit card registration through the online application on the Vietnamese bank's website	Provide essential information and documents (ID, address proof)
Output	Customers are approved for possessing a credit card	Successfully issue credit cards to customers

6.1.2 Business Diagram Process

As Korkia define a business diagram process for RPA is a sequence of actions that happen to achieve a business outcome. Institutions design a diagram process which can direct business steps to be executed in the most efficient and logical path (Duong 2017). Figure 3 illustrates the process of decision-making for credit granting in different perspectives: customer, website, data input department, assessment department, card issuer department and card distributor department.

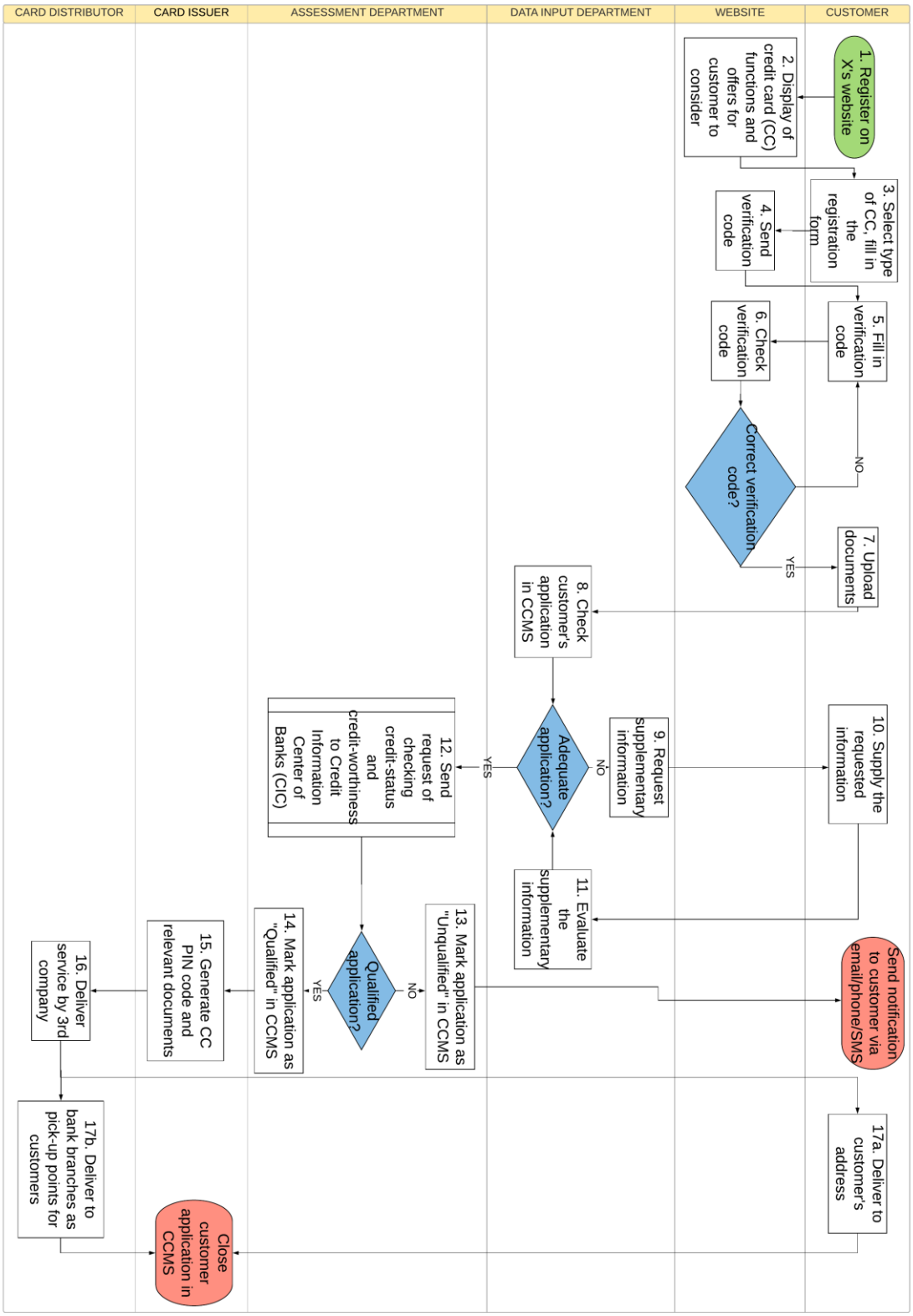


Figure 3.The process of decision-making for granting credit to customers in the private bank

6.1.3 Detail interpretations

Based on process map, specific descriptions are given to define each step in Figure 3. Acronyms are explained in Acronym Explanation.

Step	Description	Primary Independent Carrier (PIC)					
		Customer	Website	Data Entry (DE)	Assessment	Card Issuer (CI)	Card Distributor (CD)
1. Register for CC on the Vietnamese bank's website	Customer needs to register and fill in the information: Name Email address Phone number	X					
2. Display of CC functions and offers	The website displays different functions of CC include fees, purpose and benefits correlated to customer's selection.		X				

3. Select type of CC, fill in the registration form	Customer decides the appropriate type of CC and fills in the requested information: Name on passport/ID card Gender Date of birth Phone number (the phone number at this step can be different from the one from step 1. The system will automatically update the new phone number as the primary) Email address Identity Card/ Passport number Nationality Education Marital status, number of children Residential address, permanent address or company address Employment details (current working address, title, department, employment type, type of contract) Answer security verification question	X					

	Information of an immediate relative (mother/father, spouse, brother/sister, son/daughter) for verification Preferred credit limit Select pickup-point at either bank branch or preferred delivery address and complete verification step Select Confirm as agreeing to Terms and Conditions						
4. Send verification code	The website sends a verification code to registered email address of customer.		X				
5. Complete verification code	Customer types the verification code received from the website	X					
6. Check verification code	Website checks the code filled in: Code is correct: Continue to step 7 Code is incorrect: Customer retypes code or requests to send different one (return to step 4)		X				

7. Upload necessary documents to the website	Customer upload documents (identification proof, address proof, employment and income statement) to website **Note:** In case customer does not have scanned documents available, the application can be saved and submitted later when the necessary documents uploaded. Documents uploaded must be originals or valid certified copies Directory of identification and financial documents is updated correspondingly to seasonal services	X					

8. Check customer's application in Credit Card Management System (CCMS)	CCMS is the internal system which stores customers' data and is accessed by different departments in the Vietnamese bank. The website will automatically generate code for applications. They are classified into: Draft category in CCMS: inadequate applications which require additional information, documents or modification and verification. Advance to step 9 Ready category in CCMS: applications that accomplished all the requirements in step 7 (decent and precise information from customers). Advance to step 12			X			
9. Request supplementary information	For the purpose of supplementing applications or clarifying obscure information, data entry department is required to make phone calls to customers based on built-on scripts. These phone calls would be recorded and be executed every 1-2 hours/a customer. Advance to step 10			X			

10. Supply the request information	3 occurrences to consider: Customers receive the calls: DE department perform verification steps (reconfirm 2/5 written information), revise the provided data. The supplementary documents can be sent to the Vietnamese bank's email for further process Customers receive calls but don't want to provide the requested data: DE department transmit the applications to sales department for further inspection Customers do not receive calls: Contact customers via email and await responses. These applications are converted to "On Hold" status and after 30 days would be excluded.	X		X			
11. Evaluate the supplementary information	DE department evaluate the supplementary data customers provided. Auxiliary data is sufficient, precise and qualified: Advance to step 12 Auxiliary data is insufficient, erroneous: Return to step 9			X			

12. Send request of checking credit-status and credit-worthiness to Credit Information Center (CIC*)	Supplementary applications are sent to CIC for evaluating credit-status and credit-worthiness. CIC would return credit report* of inquired application in PDF format. Based on this credit report, assessment department decide how the application would process (advance to step 13 or step 14)				X		
13. Mark application as “Unqualified” in CCMS	The application is considered ineligible and the customer is denied being granted credit. The application is stored and converted to “Unqualified” in internal CCMS Notification would be sent to customer via email/phone/SMS. End of process				X		
14. Mark applications as “Qualified” in CCMS	The application is considered eligible and the customer is approved to be granted credit. The application is converted to “Qualified” and is transferred to Card Issuer department.				X		

15. Generate CC PIN code and relevant documents	The appraised application would be processed by Card Issuer department for individualizing credit card. This process includes creating CIF number* (for new customers), generating PIN code, and initializing internet banking account. Subsequently, Card Issuer Department would transmit the credit card, PIN code and associated documents to Card Distributor department. Advance to step 16					X	
16. Deliver service by 3rd party company	Card Distributor department classifies applications in two processes: Customer inquiries to collect credit card at the desired address. Advance to step 17a Customer agrees to pick up credit card at a branch. Advance to step 17b						X
17. a. Deliver to customer's address	Card Distributor transmits credit card, PIN code and appealed file paper to Express delivery service with the requested address from customer. In return, Express delivery service commits each customer a tracking number to Card Distributor department.						X

17. b. Deliver to bank branches as pick-up points for customers	Card Distributor transmits a listing of customers, their credit cards and relevant documents to bank branches by Express delivery service and obtains a tracking number in return						X
18. Close customer application in CCMS	Card Distributor department monitors delivery progress and sends notifications to Card Issuer department for close the applications when credit card delivery succeeds.					X	X

Acronym Explanation:

CIC: a public credit registry agency, which was established in the late 1990s (Dao 2006). CIC gathers, archives, processes, evaluates and anticipates credit information to subsidize banks' work. Up to 2017, CIC is the primary and most gigantic credit bureau in Vietnam. Thus, CIC is considered reliable for its old-establishment, but its technology appears to be obsolete (Business Information Industry Association 2017).

CC report: Credit report - a report which includes data about credit activity and current credit condition of an entity such as loan paying history and the status of credit accounts. Credit reports often comprise of personal information, credit accounts information and collection items. Personal information is connected to a credit account in the past, including ID/passport number, birth date, current and former address and phone number. Credit account consists of data about the current and historical account, type of account (mortgage, installment, revolving), credit limit or credit amount, account balance, account payment history, opening and closing date of account, name of the creditor. Collection items are public records of liens, foreclosures, bankruptcies, civil suits and judgments. When making up a typical credit decision, some elements are considered include the bill-paying history, the current unpaid debt, the number and type of loan accounts, the period of loan account (Le 2017).

CIF number – Customer Information Form number: a distinguished number concerned a digitized file, which carries all personal and account-related data of one customer in the bank (United States Patent 1983, 25)

6.2 Process analysis

By organizing workshops to meet up directly with employees, the authors have identified a potential sub-process for RPA development. Figure 4 zooms in a chosen sub-process that locates inside a square area.

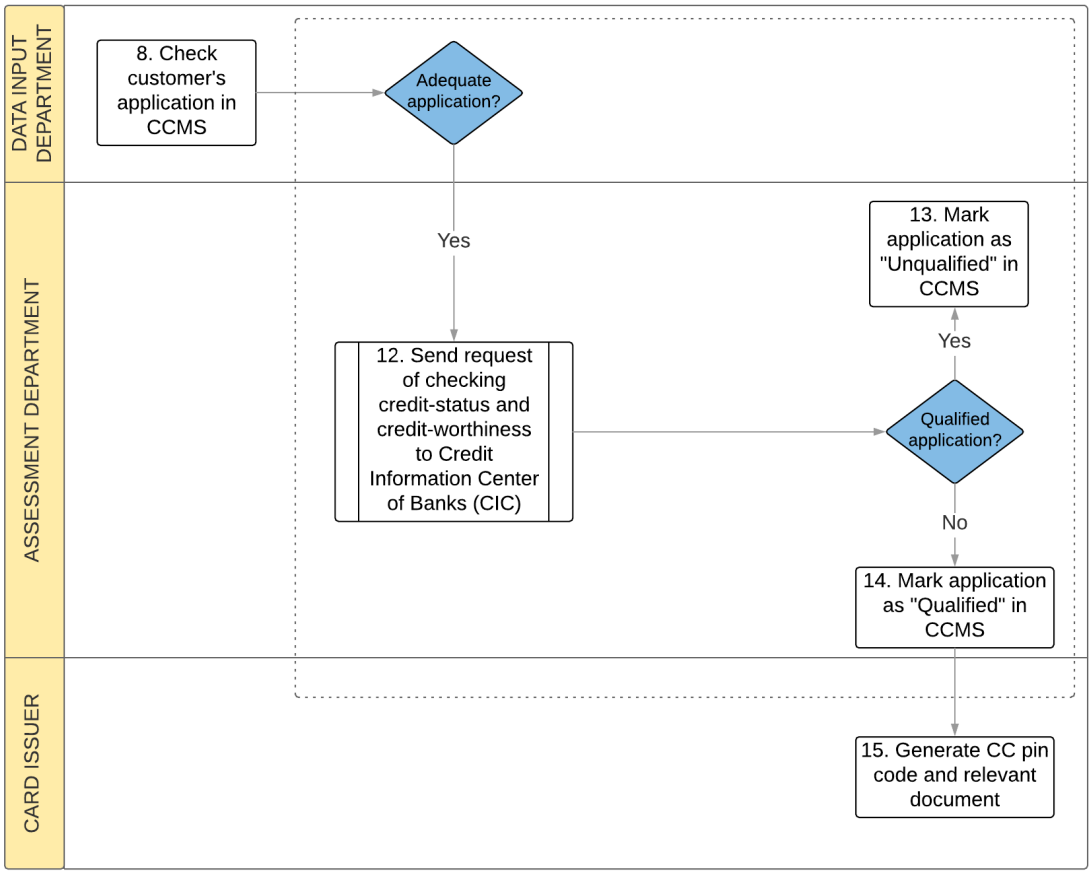


Figure 4.A chosen sub-process for RPA development

The sub-process' activities consist of requesting credit reports by supplying customer information to CIC turn by turn and analyzing the result afterward. It is prioritized to be automated because it includes a significant manual workload, especially when the Vietnamese bank is about to enlarge the size of business. The more customers involve in a service, the more tasks at hand employees need to deliver. The issue requires the Vietnamese bank to recruits more employees and expand their working space. The cost of delivery and the apprehension of productivity's decrease are raised at an urgent problematic issue. Therefore, RPA is proclaimed to be a solution not only to optimize that cost but also to improve the productivity by minimum the participation of labors and replace them with a robot. However, a process which might be appropriate to apply RPA must satisfy three basic conditions. Firstly, a process consists of repeated tasks and is performed manually by employees based on the requested schedule. Secondly, a process development is supported by RPA tools. Thirdly, a

process is under quality control and can be tracked by human anytime. (Duong 2018). Acknowledging customers' difficulties in everyday tasks through discussion, the authors build up a sub-process diagram that describes in detail all manual steps that employees should deliver after step 8 to step 14. Figure 5 presents a process map within that scope.

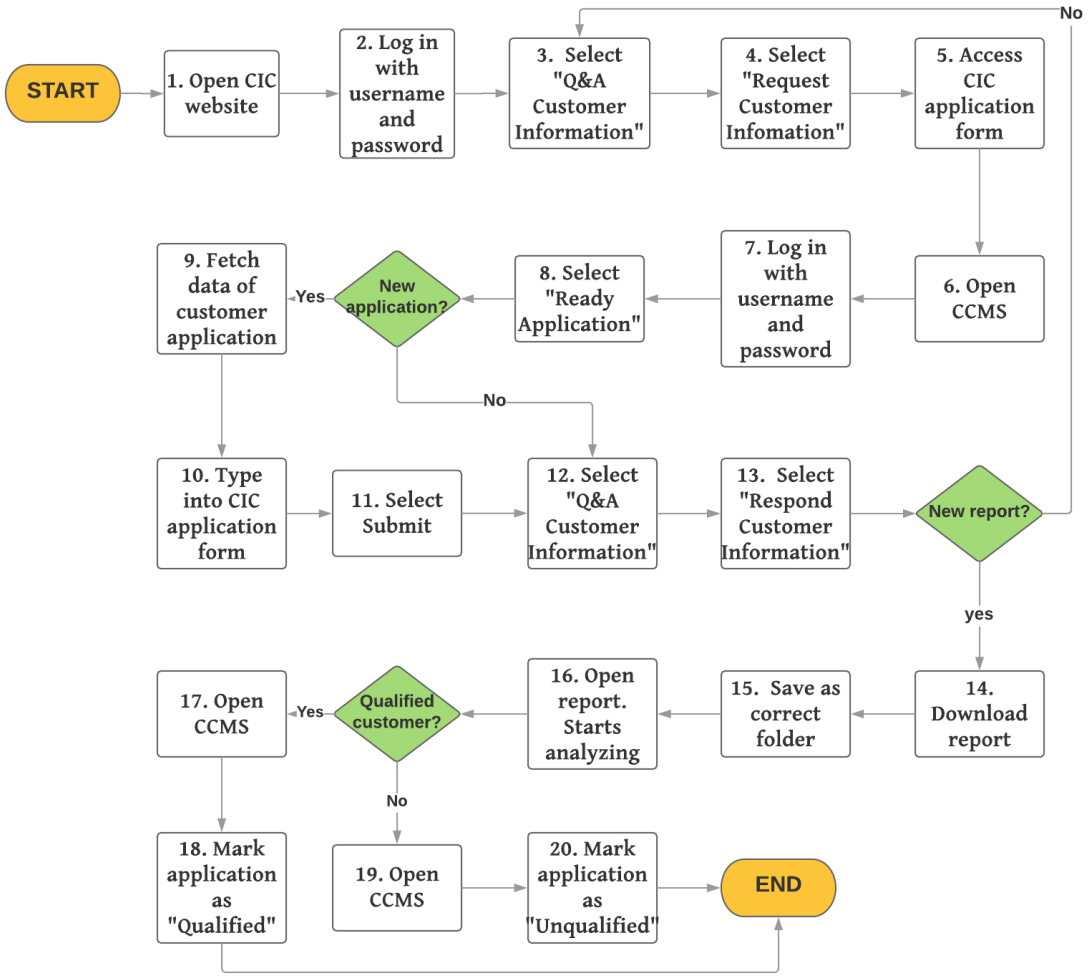


Figure 5. A process diagram of employee's manual workload of analysing credit report from CIC system

Steps	Short Description
1	Open CIC website: www.cic.org.vn
2	Log in with username and password
3	Select "Q&A Customer Information" section in navigation bar
4	Select "Request Customer Information" section afterward

5	Access CIC application form in “Request Customer Information” page
6	Open Credit Card Management System (CCMS)
7	Log in with username and password
8	Select “Ready application” to access the data table of customer application with adequate information.
Decision (1)	Check whether it has new ready customer application, if yes then open customer application form, else then advance to step 12
9	Fetch data from application form
10	Type information into CIC application form with corresponding fields.
11	Select submit to send a request to CIC
12	Select “Q&A Customer Information” section in navigation bar
13	Select “Respond Customer Information” section afterward
Decision (2)	Check whether CIC issues any new credit report, if yes then go to step 14, else then go back step 3
14	Download credit report
15	Save as correct folder based on the Vietnamese bank’s rule
16	Open credit report. The employee starts reading and analyzing information from the report
Decision (3)	Check whether a credit report is qualified the Vietnamese bank’s standard condition, if yes then go to step 17, else then go to step 19
17	Open CCMS
18	Select button “Qualified” in CCMS’ customer profile
19	Open CCMS
20	Select button “Unqualified” in CCMS’ customer profile

Based on that, the authors will deliver an analysis that demonstrates the process is applicable to RPA.

First condition

The process is confirmed as a repeated and routine job. There are currently 1500-2000 customer applications registered through online site every day. Each application has been processed with a similar sequence. Employee handles specific tasks in the sequence which has been described in figure 5.

Second condition

There is a notice that the unmentioned action of requesting customers for supplementary documents or information does not belong to an RPA process. RPA may cause errors since the activities of contacting customers are not defined by rules but by social skills. In addition, the communication sometimes requires employees to meet customers physically which a software robot cannot handle. Therefore, a process automation will only start as soon as a customer application has sufficient information and is ready for CIC checking. With that choice, a development is confirmed to fit in with RPA tool. There are four demonstrations that bring clarification.

Firstly, a robot must handle well activities among CCMS and CIC web app. Hence, it needs the ability to work with multiple software applications in different levels. In a high level, it can open, switch between activated apps and display app commands and functions. In a lower level, it can select and click different layouts. RPA tools provide the function of screen scrapping for that requirement. According to Brain (2016), screen scraping in RPA is a method of scraping a display of texts, user interfaces of apps in desktop and of website. The activity is to capture data in a more convenient way without assessing to the database. Therefore, the feature allows a robot to identify interfaces of opened apps and to locate any command or query in intended screens of buttons or icons.

Secondly, a robot must recognize different types of data in CCMS. Thus, it needs the capability to categorize data with rule-based structure. The action of data categorization supports robot in defining data meaning. RPA tools supply a function of data scraping for that. UiPath (2018) describes data scraping in RPA as a method that extracts structured data from desktop apps or websites. A structured data is organized with certain rules and stored in a data table. Any information in data table can be manipulated by using algorithm. Therefore, with data scraping, a robot will not only classify data and define its meaning but also enable to do many other data-related tasks.

Thirdly, a robot can transfer data from CCMS to CIC web app and vice versa. Consequently, it needs the competence to relocate data between apps. RPA tools support the function of recording. Brain (2017) explains recording as a feature that allows a process steps to be captured on the screen and converted into series of actions. A classic recording enables a robot to produce any automated sequences inside a system. However, implementing specific recording methods can be faster and more accurate such as desktop recordings which can deliver a direct stimulation in any desktop-related apps or web recording which can support better automation in browsers or Citrix recording which specializes in capturing sequences in a virtual environment (UiPath 2018). Hence, the action of relocating data can be recorded by RPA tool easily.

Lastly, a robot will examine and determine the customer information of CIC report for decision making independently instead of employees spend time on the analysis. On that account, a robot is required to have the intelligence in making a decision under control of business users. RPA tools allow a Decision Model and Notation standard (DMN) to be linked to a development platform (Landsheer 2017). A DMN is used for standardizing a decision-making concept and automating it with decision requirement diagram (DRD) (Decision Management Solutions 2016, 6). A DRD describes a sequence of process tasks which contains decisions, data input and output, list of requirements and relevant knowledge to build up an analytics framework (Decision Management Solutions 2016, 6-7). As a consequence, the process automation in decision-making is fully supported by RPA.

Third condition

The beauty of RPA compared to traditional IT solutions is business users can interact with a robot, control and evaluate every step of its process through PC's screen. In a high level, people can see all displays of how a robot collaborates with opened apps, browsers and data sources when running a process. Users are also allowed to communicate with robots in some points when they are in need. In a lower level, people can track any operating steps by accessing the process diagram which is architected inside a robot. This level allows business users to not only detect failures but also train it with additional sequences or business rules by only using the existing library of robot's functions without the involvement of coding (UiPath 2018).

In conclusion, a chosen sub-process satisfies all three conditions to become a potential case of RPA development. First of all, it is a repeatedly manual job. Secondly, it is able to develop by RPA tools. Finally, it can be managed and controlled by business users.

6.3 Requirement gathering and analysis

Software Requirement Specification (SRS) document is a requirement description of a software to be developed. Those requirements ought to provide sufficient details which allow designers, developers and testers can perform their job consistently. (Software Requirements Specifications Document 2018).

Based on the method of group discussion and a guideline of SRS document, the task is to design a list of project requirement. A list is not the comprehensive SRS document but it will cover adequate information for a pilot to be successfully developed. Firstly, it discusses the checklist of resources that the Vietnamese bank agrees in contract with Korkea. Secondly, it outlines a checklist of validation requirements that a robot must pass to be confirmed as a successful RPA product. Then, a robot's vendor will be finalized in this stage as well.

Checklist of resources agreement

Resources	Description
Workstation	A workstation is defined as a computer or laptop that is used for project development. A robot is required to develop a pilot product in the workstation with higher display resolution, faster processor, and greater capacity in RAM than a personal PC. Then, it will be integrated with the Vietnamese bank's system.
Software Applications	A robot developed to automate the chosen process must have the right to access all involved software applications. Therefore, the Vietnamese bank should allow Korkia to have username and password of required software such as CCMS and CIC web app. In addition, the Vietnamese bank should provide instruction on how to use those applications as developers' supporting documents.
Robot	A pilot project is only to develop a sub-process. Thus, one robot is efficient to handle well. Chosen RPA tool is required in the stage of development since the Vietnamese bank needs to work with the chosen vendor or allow Korkia as the Vietnamese bank's representative working with them to install their robot's package into the Vietnamese bank's system.
Testing Environment	A testing environment is an environment that contains software, hardware and network components simulating the production

	environment. A software product is executed in a testing environment to examine the stability of the software and debug any technical issues that might happen. (Tutorials Point 2018b). In this project, the Vietnamese bank needs to supply a testing environment. Robot will be activated and run on that before going to actual environment.

Checklist of validation requirement

Validation Criteria	Description started with "A robot can…"
Deployment	Can be installed in the Vietnamese bank's system. Can perform in a testing environment. Can be compatible with the selected browser.
Functionality	Can be trained to work in every step of a chosen process. Can open applications and log in automatically with username and password. Can fetch data from one app and pass to another app. Can identify component and image's positions in app's layout and performs manual tasks such as clicking, typing or sending keyboard shortcuts. Can perform decision-making action based on certain rules.
Efficiency	Can deliver job tasks faster and more accurately than human performance. Can completely take the place of human role in the process
Control	Can stop running when exception cases happen Can supply reports of every action that has been done Can adapt process changes handily without coding effort
Exceptions	Can assign exceptions to manual work

	Can provide justification in every case of exceptions.

Based on checklists of resource agreement and validation requirement, UiPath has been chosen. Firstly, it provides a powerful core functions with recording, screen scrapping, data fetching and decision-making process with complex algorithms. Secondly, a robust control room and system management allows errors and failures to be tracked immediately and handily. Hence, developers will shorten their development time and be more efficient in robot's testing phase. Thirdly, a sturdy analytics system permits UiPath robot to perform data manipulation competitively. Fourthly, UiPath is trusted due to its current position as one of the top RPA leaders. Lastly, UiPath's licence model is an annual subscription license which has no commitment in number of acquiring robots. Thus, it is applicable to a pilot case where the Vietnamese bank's target is to test the effectiveness of RPA in their banking system. Therefore, a solution ought to be cost efficiency.

6.4 Process roadmap design

6.4.1 Process Overview

The process diagram in Figure 5 section 6.2 is considered as a process map for RPA implementation. However, with more than 20 steps in that process, it is protracted for the authors and stodgy for readers to go through all those steps in this thesis. On the other hand, CCMS – Credit Card Management System is an internal system of the Vietnamese bank which requires privacy of information and high confidentiality that the authors might not be able to describe it in detail. Consequently, in the scope of this thesis, to provide an understanding of RPA development process in general, in architecture and in development, the authors will work from decision (2) to step 15 from Figure 5 (equivalent to step 12 in section 5.1.3). First of all, the authors clarify comprehensive information about the process chosen for implementing RPA, in term of automation:

Process Details	
Process full name	Obtain Client Credit Report
Function	Computerizing
Department	Assessment
Process short description (operation, activity, outcome)	Log in to CIC website and download client credit report to desired folder.

Process schedule	Daily
# of items processed / day	200 - 230 clients
Average handling time per client	2 min / client

Identify intakes and expected results for standardizing the process of evaluating client application.

Input	Login credentials from CIC website
Output	Credit report

6.4.2 Detailed process roadmap

This process map involves opening CIC website, checking whether there are new customers and downloading credit reports from those recent customers.

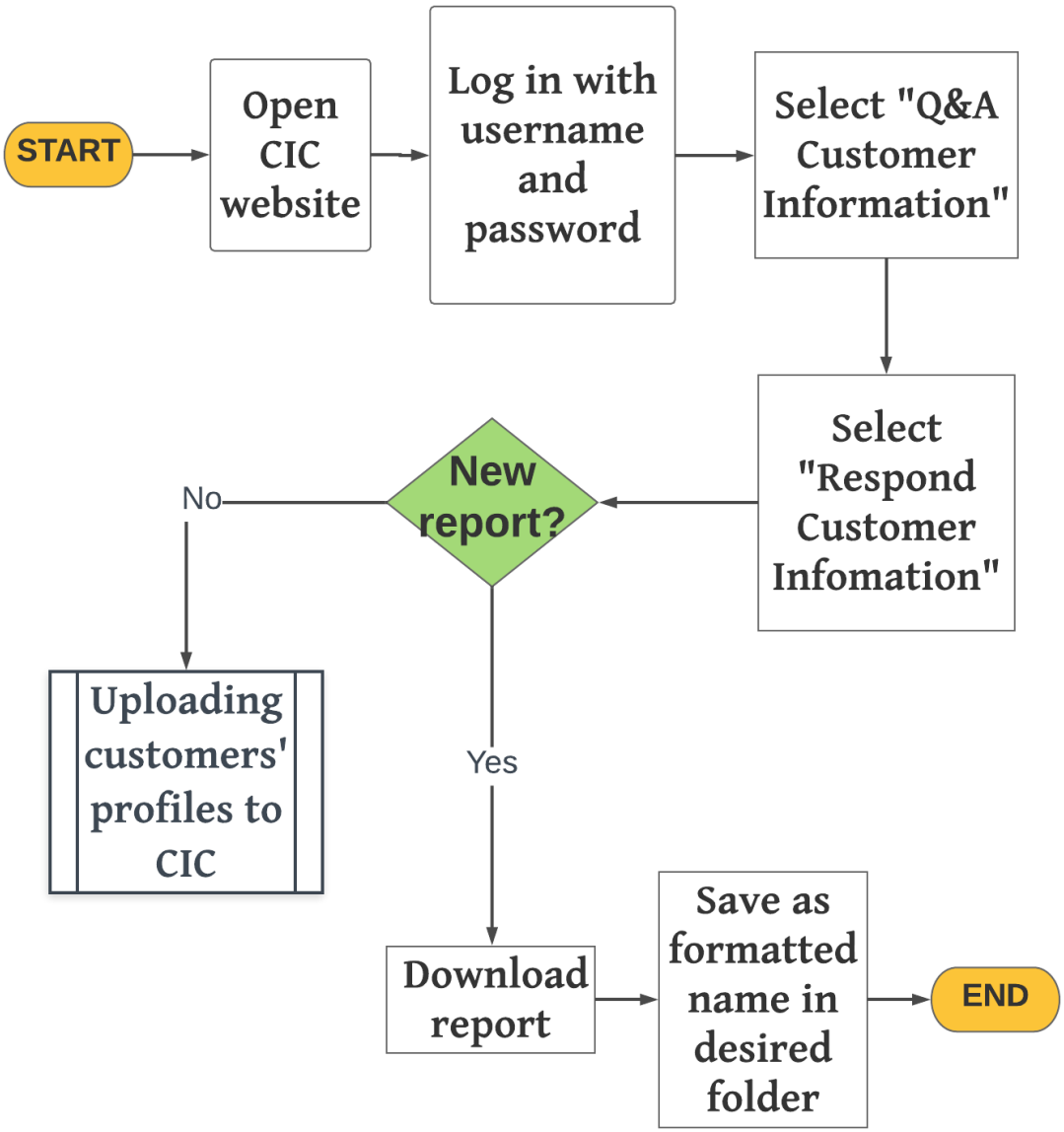
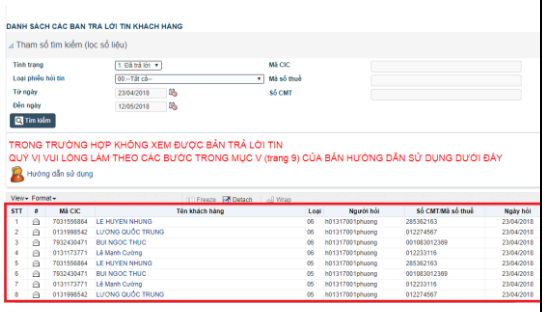
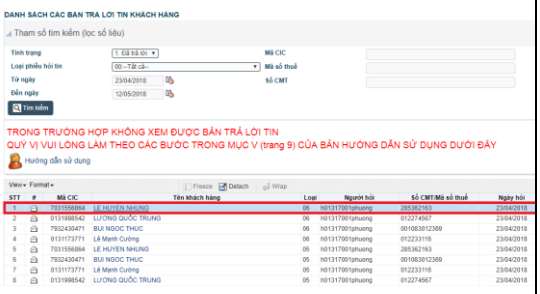
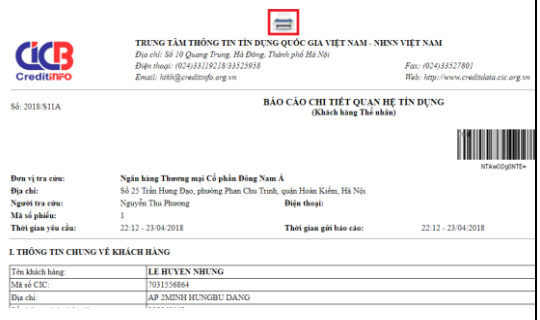


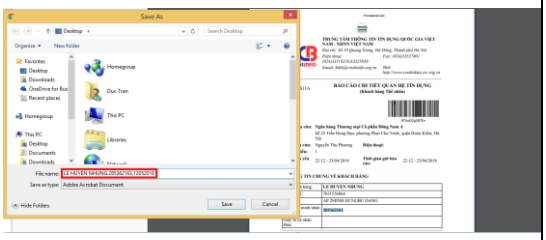
Figure 6. A process map of downloading the credit report of customer from CIC

6.4.3 Detailed process steps

Detailed process steps comprise of designed step, screenshot, expected result and remarks. Each of these categories plays an important role in designing the structure of the process roadmap. Step description illustrates robot's step that is designed to replace manual work of employees. It is written in detail and distinctly by including minor operations needed to be taken. Screenshot is included to help developers identify the appropriate elements to work with. Expected result describes the outcome of the robot's performance in each step, which is predicted under excellent condition. Exceptions are occurrences during the operation that break the normal flow of the whole process. Exceptions' solutions will be recommended in this architecture process roadmap in section 6.4.5.

#	Step description	Screenshot	Expected Result	Exceptions
1.1	Open the CIC website		The display of CIC website	Possible exception: Handle exception if CIC website is not available
1.2	Log in to the system. Required input data: username, password and CAPTCHA code provided by 3rd party service		Access to main home screen	Possible exception: Handle exception of incorrect username or password
1.3	Access Hoi Tra Loi Tin Khach Hang (Q&A Customer Information) – where user can pick a specific service		The display of services under Q&A Customer Information section	Possible exception: Handle exception if CIC website is not available
1.4	Access Tra Loi Tin Khach Hang (Respond Customer Information) to view listings of all the customers		The display of customers listing to process	Possible exception: Handle exception if CIC website is not available

	needed to be processed.			
1.5	**For each new customer** of listings, perform the following steps:			Possible exception: Handle exception if there are no new customer to process
1.6	Click the name of new customer to retrieve the credit report (Output data: Credit report)		A pop-up window of credit report	Possible exception: Handle exception if the credit report is unavailable
1.7	Retrieve Client Name and ID Number of customer from credit report		Client Name and ID Number of customer	
1.8	Print out the credit report		The display of printing properties	

				
1.9	Save the credit report as name “ClientName.ID-Number.Date-Now” in the desired folder		A PDF file with the right formatted name	
1.10	Close the pop-up window and Continue with the next new Client			

6.4.4 Exceptions handling

Exceptions are classified into 2 types: business exception and technical exception (UiPath Orchestrator Guide 2018). Business exceptions are errors caused by essential specific data missing or incomplete while technical exceptions are failures in application execution as the process operating. Additionally, there are 2 states of exceptions: known and unknown. The known exceptions are situations encountered earlier, from which distinct actions and workarounds are defined for each case. On the contrary, unknown exceptions are circumstances have never happened before and requires immediate actions from human. Consequently, predicting the exceptions and providing solutions prevent the process from breaking unexpectedly.

#	Exception Name	Step #	Area	Type	Solutions
1	CIC website not loading	# 1.1 # 1.3 # 1.4	Technical	Unknown	Close web browser and run the sequence again. Retry 2 times

2	Incorrect username or password	# 1.2	Business	Known	Send email to exception@example.com contains "The username or password is incorrect. Please check and restart sequence. Thank you"
3	No new customers to process	# 1.5	Business	Known	Return to step 3 "Select 'Q&A Customer Information'" in *Figure 5* to check whether new customers are appended or not
4	Credit report unavailable	# 1.6 # 1.7	Technical	Known	Allow pop-up window in browser settings. Close web browser and retry.

6.5 Process development

Robotic Enterprise Framework is a concept of development that proposes a strategy of collecting, reading and customizing Robot's configuration scientifically. In addition, it suggests a logical and effective path for exception handling and errors tracking efforts (Dunareanu 2017). REFramework supports RPA developers a reliable technical guideline which has been tested. In this section, the authors will discuss the framework's walkthrough and demonstrate its practice by implementing the process roadmap inside the robotic enterprise structure. As a result, the target is to persuade Korkia to officially launch this framework into different RPA projects.

6.5.1 REFramework: Robotic Enterprise Framework

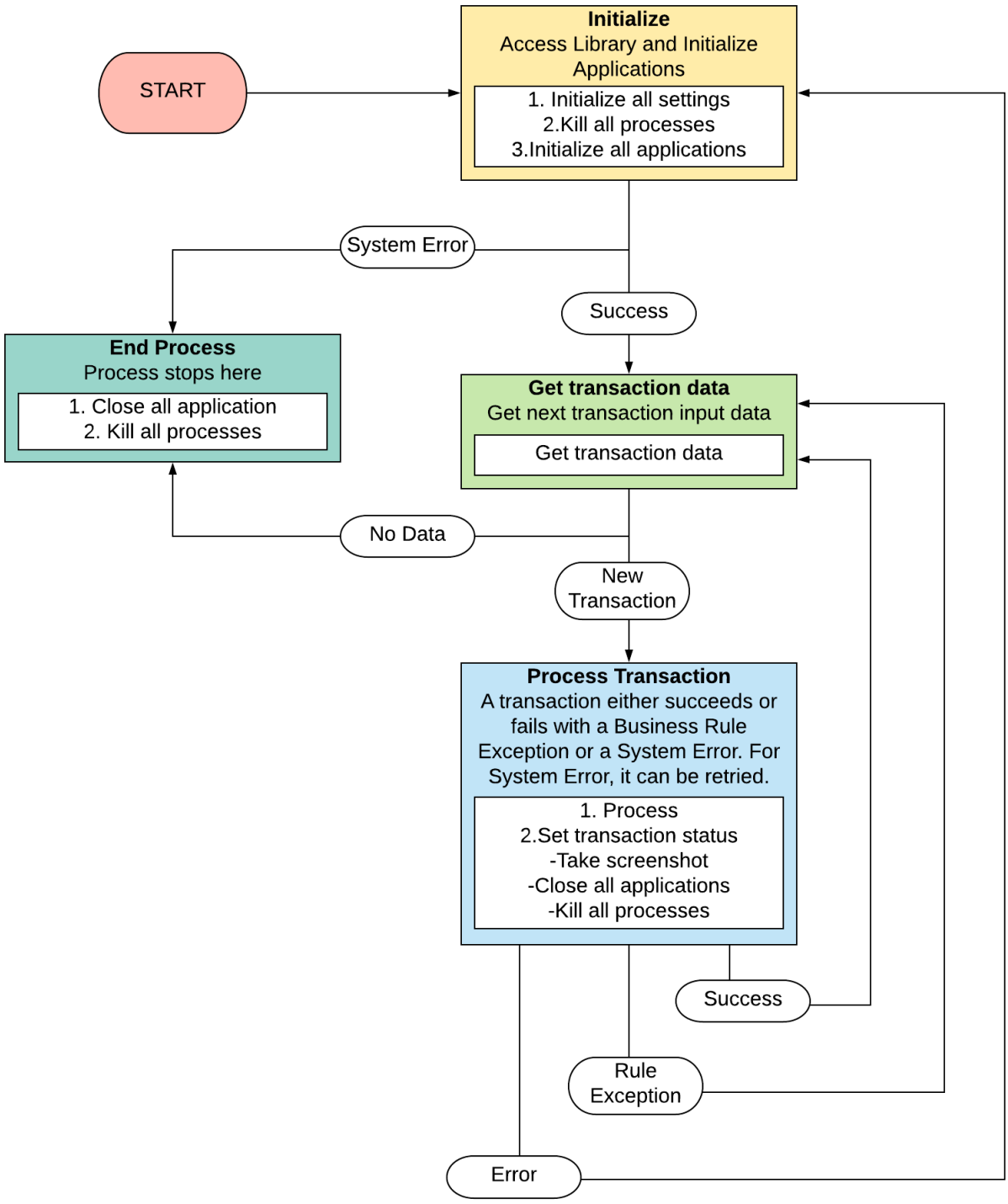


Figure 7. A Logical Diagram of REFramework (Dunareanu 2017)

6.5.2 REFramework interpretation and its implementation in the Vietnamese bank's roadmap

Based on figure 7, there are four states that form a comprehensive roadmap for a robot which are Initialization, Get Transaction Data, Process Transaction and End Process. The automation starts with the Initialization which comprises three main activities: initialize all settings, kill all processes and initialize all applications. The first state's outcome is to let robot access the configuration library and initialize all relevant applications. The second state is Get Transaction Data. The outcome of robot's performance is to get data from requested sources. The third state is Process Transaction where a robot needs to do two main tasks: process defined transactions and set a transaction status afterward to examine whether it is a success or a failure due to system errors or other exceptions. The fourth state is End Process. There are two main activities that a robot needs to complete. A robot must close all applications and kill all processes. The outcome of this last state is to stop all processes. In this interpretation, the authors will describe in detail the logic in each state of REFramework and recommend the implementation of it into X's system based on the process roadmap.

The initialization

The Initialization is a state where developers can build configuration library manually by creating a database or using Excel's sheets to store data. Inside the library, all compositions which will be used in different steps of a process ought to be generated. Each component is designed with key name and its value. A value contains a unique meaning of a specific key name in the library. Then, a robot defines a connection between the key name and its value in case whenever any key names are called, following values are also activated. Data is fetched from a library instead of being integrated inside the robot's memory since it is more efficient for developers when they can always change robot's configuration without changing any structure of a robot. In addition, using external resources allows robots to maintain its speed and performance in a long run. Therefore, by connecting with the external library, a robot initializes all required settings that are used in a project.

After that, a robot kills on-going processes before continuing the initialization of all needed software. This action supports robot in optimizing its internal memory. To open requested software applications, a robot should know each app's username and password. Window Credential Management (WCM) stores all credentials of window apps. Thus, a robot must be allowed to fetch data from WCM. In case a robot cannot search for the data in WCM, it needs to ask for the support of human by sending them email and collecting needed data from their reply.

When the initialization of all settings and applications is completed successfully, a robot moves to the state of Get Transaction Data. However, when system errors occur, a robot moves to the state of Ending Process.

Those discussed structure of the Initialization is set as foundation for an RPA development of the Vietnamese bank's process. Therefore, the CIC website needs to be opened at this state with its username and passwords stored from WCM. A solution for incorrect username and password is counted as system errors. Hence, it is treated according to the above explanation.

Get Transaction Data

The Get Transaction Data is a state that a robot will get new input from external sources that has been defined in process roadmap. It can be a data table under spreadsheets, databases, emails, software apps or web apps.

To fetch data from that input data table, there is a transaction number, which is set as 1 by default and located inside a robot to count transaction times. It allows a robot to make a comparison between the number of transaction and the number of data rows of an input data table. When the transaction number is less than or equal to total rows of an input data table, a robot obtains that data, then move to the third state of Process Transaction. However, when the transaction number is more than total rows of a data table, a robot will understand that there is no information to acquire, then it moves to the fourth state of Ending Process.

In X's process roadmap, the action of accessing input is not mentioned due to the involvement of CCMS which is an internal system of X. Nevertheless, the algorithm inside a robot is applied as above discussion. A robot needs to search for input as a data table of customer information in CCMS, make a comparison between a number of transactions and a number of customer profiles. A decision of whether a robot will fetch a specific customer profile data or not is made based on that calculation. A robot only collects data when the number of input customers from a CCMS data table is equal or less than a number of transactions. It is comprehensible because times of robot's successful performance is similar to times of transaction.

Process Transaction

A Process Transaction is a state where a robot handles the transaction based on a defined input. A transaction can be succeeded without exceptions or failed with exceptions in business rules or system errors. A business rule exception describes an issue of incompleteness or missing in data input that prevents a robot to process further. This exception cannot be solved by retrying the action. Instead, it needs human involvement to fix the issue (UiPath Orchestrator Guide 2018). Meanwhile, system error exceptions describe technical issues such as a software cannot be opened, system's freeze or an unload browser. Those exceptions can be solved by retrying the action (UiPath Orchestrator Guide 2018).

Due to different circumstances, a robot is trained to examine the process status while it performs each transaction. If there is no exception or a business exception, a robot sets notified status in its tracking report, returns to the state of Get Transaction data and get next transaction input. If there is a system error, a robot sets status as System Errors in tracking report. Then, it retries transaction a specific number of times to let the process's outcome be achieved. If the retry is successful, a robot returns to Get Transaction data. Otherwise, it returns to the state of Initialization.

In process architecture design, activities from 1.3 to 1.9 section 6.4.4 belong to the state of Process Transaction. This roadmap follows as same process logic as the REFramework's description. When a transaction is processed successfully, a robot comes back to Get Transaction Data to fetch new input data from CCMS. However, the actions of step 1.3 and 1.4, which are "Access Q&A Customer Information" and "Access Respond Customer Information" might occur System errors that the CIC website is not loading because the browser may freeze randomly. Therefore, a robot is trained to retry 2 times before deciding the action of whether returning to Get Transaction Data or moving to the Initialization. The actions of step 1.6 and 1.7 which is downloading a credit report from a list of CIC might also contains system errors. It happens due to unsupported browser. Hence, a robot changes browser configuration, retries by closing unsupported browsers and open the new supported version.

End Process

An End Process is the last state that completed processes stop here. Therefore, a robot closes all applications normally. In case the applications are failed to close due to system errors, a robot forces them close by its functions.

In process roadmap, CIC web is currently opened. A robot closes them to stop the automation and wait for the next robot's schedule.

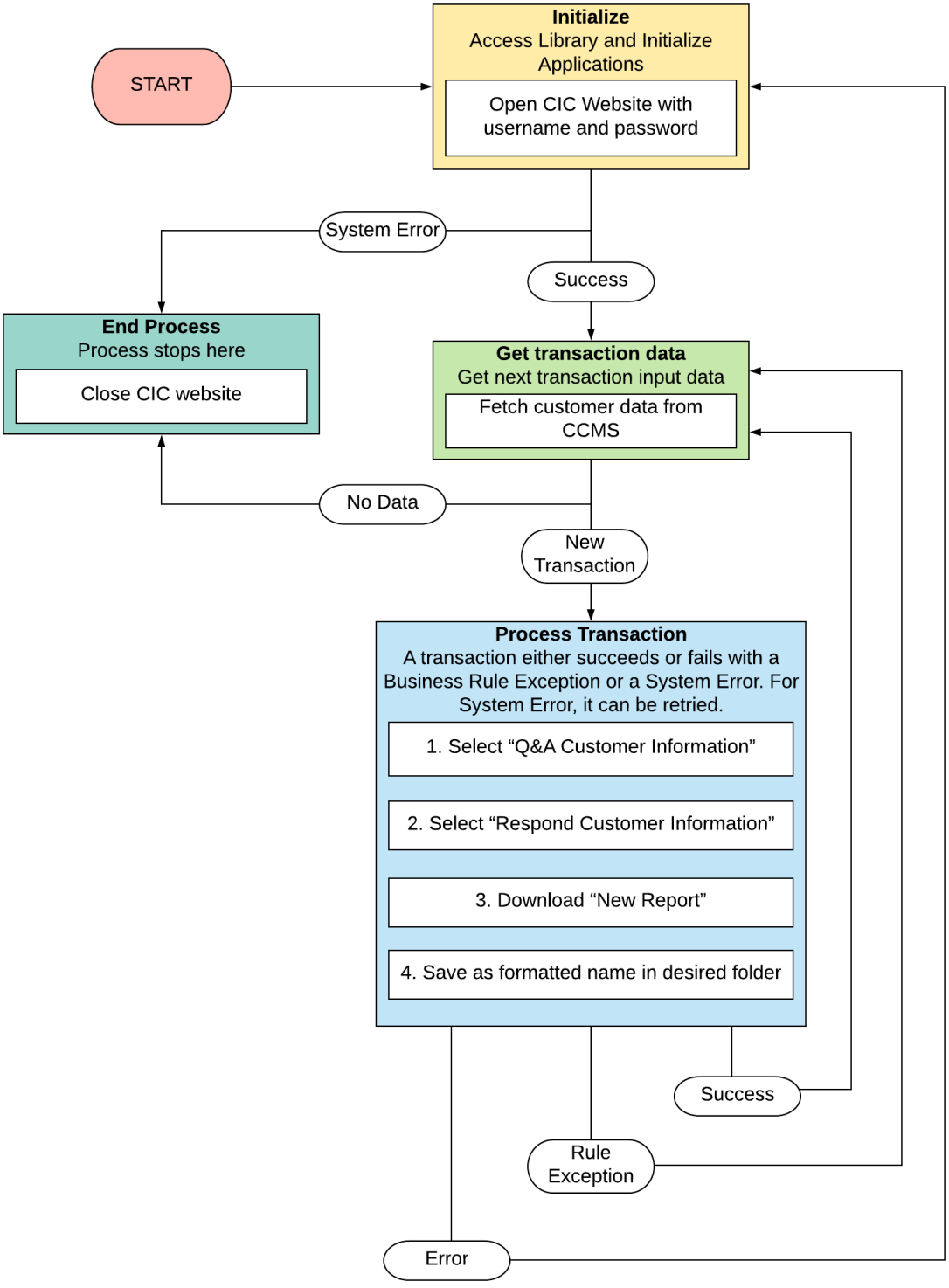


Figure 8. The implementation of REFramework in the Vietnamese bank’s process roadmap

In overall, Robotic Enterprise Framework can be executed successfully with a process roadmap. The framework not only perform well the tasks but also handle strictly and accurately exceptions that might happen during the process of automation. Therefore, REFrame-

work should be considered officially its future of implementation in Korkia's service. The concept has demonstrated its practicality and productivity. It also benefits developers to work with the same robot's structure, which can support effectively in teamwork and maintenance service afterward.

7 Conclusion

In conclusion, the Vietnamese bank is appropriate to implement RPA in their system. The solution increments the productivity, cost efficiency and minimum of human errors by using a software robot for automation in any knowledge work that requires the bank's employees to perform routinely and repeatedly. Korkia applies RPA successfully in a specific process of permission for granting credits to online customers. Based on the development of that case, the research thesis delivers all the initially proposed objectives. Firstly, the theoretical background provides Korkia with a strong attainment of RPA in banking that helps Korkia in compromising with new-banking-client-to-be. Secondly, the RPA vendor's overview and metaphor would be beneficial in choosing the pertinent RPA software for designing framework architecture. Finally, the method of development, implementation plan and framework architecture design are efficient documents that could be exploited to administer identical elementary processes within any specific bank. RPA demonstrates its necessity in the era of automation where robots is developed to support human in different job tasks. This thesis R&D is considered as a foundation for the authors to continue their study in the implementation of artificial intelligence in RPA that can potentially upgrade a software robot with recognition ability.

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Figures

Tables